DESCRIPTION

ELECTROLESS PLATING METHOD

TECHNICAL FIELD

The invention relates to an electroless plating method for applying electroless plating to an object to be plated, made of a constituent material to which an electroless plating can not be directly applied, and in particular, to an electroless plating method suited for forming a conductive film on end faces of metal or semiconductors, to which an electroless plating can not be directly applied.

BACKGROUND TECHNOLOGY

As a thermoelectric device generates a voltage if the opposite ends thereof are maintained at different temperatures, the same is utilized for thermoelectric power generation, and conversely, if electric current is caused to flow therethrough, an exothermic reaction occurs at one end thereof while an endothermic reaction occurs at the other end thereof. Accordingly, the same is also utilized in a cooling apparatus, and so forth, making use of an endothermic phenomenon. Because such a thermoelectric device as described above is simple in construction, and has an advantage over other electric power generators in implementation of miniaturization, and so forth, hopes run high that the same will be applied to portable electronic equipment such as an electronic wrist watch.

The thermoelectric device is made up of a plurality of thermocouples arranged in series, each composed of a p-type

semiconductors, in a range of several to several tens of μm. The more minuscule the structure of the thermoelectric device, the more difficult it becomes to form the conductive films selectively only on the thermoelectric semiconductors. It is therefore a major problem in the fabrication of the thermoelectric device to selectively form the conductive films by electroless plating.

The invention has been developed to solve those problems, and an object of the invention is to provide an electroless plating method whereby conductive films can be formed even on the surface of a constituent material to which it is not possible to apply electroless plating, and further, to selectively form the conductive films uniform in thickness on end faces of respective thermoelectric semiconductors formed of a constituent material to the surface of which it is not possible to apply electroless plating, thereby enhancing productivity and reliability of a thermoelectric device as fabricated.

DISCLOSURE OF THE INVENTION

An electroless plating method according to the invention comprises the steps of forming a metallic film made of a metal on which an electroless plating film can be deposited on part of the surface of an object to be plated, or causing the metal to be in contact with part of the surface of the object to be plated, made of a constituent material to which an electroless plating can not be applied, and dipping the object to be plated having the metallic film formed thereon or having the metal in contact therewith in an electroless plating bath, and forming an electroless plating film on the surface of the object to be plated, without

the metallic film formed thereon and the metal in contact therewith.

Further, the electroless plating method according to the invention may comprise the steps of forming a metallic film made of a metal on

which an electroless plating film can be deposited on part of the surface of an object to be plated, or causing the metal to be in contact with part of the surface of the object to be plated, made of a constituent material to which an electroless plating can not be applied, dipping the object to be plated having the metallic film formed thereon or having the metal in contact therewith in an electroless plating bath, and forming an electroless plating film on the entire surface of the object to be plated, containing the metallic film or the metal, removing the metallic film or the metal, and portions of the electroless plating film, covering up the metallic film or the metal, from the object to be plated, and dipping again the object to be plated subjected to the steps described above in the electroless plating bath.

With any of the electroless plating methods described above, the object to be plated may be made of plural kinds of constituent materials or may be a thermoelectric semiconductor.

Further, with any of the electroless plating methods described above, the electroless plating film may be formed so as to have a dual-layer structure comprised of not less than two metallic films.

The electroless plating method according to the invention, applied to the fabrication of a thermoelectric device, may comprise the following respective steps:

(1) the step of forming a metallic film made of a metal on which an electroless plating film can be deposited on one of end faces of a thermoelectric device block formed integrally with a plurality of thermoelectric semiconductors, disposed with an insulation layer interposed therebetween, respectively;

(2) the step of dipping the thermoelectric device block having the

metallic film formed thereon in an electroless plating bath, and forming an electroless plating film on the metallic film and the other end face of the respective thermoelectric semiconductors, on the side thereof, opposite from the end face on which the metallic film is formed;

(3) the step of removing the metallic film and a portion of the electroless plating film, covering up the metallic film; and

(4) the step of dipping again the thermoelectric device block subjected to the steps described above in the electroless plating bath, and forming an electroless plating film on the end face of the respective thermoelectric semiconductors from which the metallic film is removed.

With the electroless plating methods described above, the following steps (5) to (8) may be substituted for the abovementioned steps (1) to (4):

(5) the step of causing a metal on which an electroless plating film can be deposited to be in contact with a part of at least one of end faces of respective thermoelectric semiconductors of a thermoelectric device block formed integrally with a plurality of thermoelectric semiconductors, disposed with an insulation layer interposed therebetween, respectively;

(6) the step of dipping the thermoelectric device block having the metal in contact therewith in an electroless plating bath, and forming an electroless plating film on the entire surface of the respective thermoelectric semiconductors, except the part thereof, in contact with the metal,

(7) the step of separating the metal in contact with the respective thermoelectric semiconductors therefrom; and

(8) the step of dipping again the thermoelectric device block subjected

to the steps described above in the electroless plating bath, and forming an electroless plating film on the part of the end faces of the respective thermoelectric semiconductors, in contact with the metal.

Further, with the electroless plating methods described above, the following steps (9) and (10) may be substituted for the abovementioned steps (1) to (8):

(9) the step of forming a metallic film made of a metal on which an electroless plating film can be deposited on an end face of respective insulation layers disposed on the side of one of end faces of a thermoelectric device block formed integrally with a plurality of thermoelectric semiconductors, disposed with the respective insulation layers interposed therebetween, such that the metallic film spans the respective insulation layers and a portion of respective end faces of both the thermoelectric semiconductors adjacent to each other across the respective insulation layers alternately disposed; and

(10) the step of dipping the thermoelectric device block having the metallic film formed thereon in an electroless plating bath, and forming an electroless plating film on the metallic film and both end faces of the respective thermoelectric semiconductors with the metallic film formed on the portion of the end face thereof.

Still further, with the electroless plating methods described above, the following steps (11) and (12) may be substituted for the abovementioned steps (1) to (8):

(11) the step of forming a metallic film made of a metal on which an electroless plating film can be deposited on either an end face or the other end face of respective insulation layers, alternately, on the sides of both end faces of a thermoelectric device block formed integrally with a

plurality of thermoelectric semiconductors, disposed with the respective insulation layers interposed therebetween, such that the metallic film spans the respective insulation layers and a portion of respective end faces of both the thermoelectric semiconductors adjacent to each other across the respective insulation layers; and

(12) the step of dipping the thermoelectric device block having the metallic film formed thereon in an electroless plating bath, and forming an electroless plating film on the metallic film and both end faces of the respective thermoelectric semiconductors with the metallic film formed on the portion of the end face and the other end face thereof.

Yet further, with any of the electroless plating methods comprising the abovementioned steps (1) to (12), use may be made of the thermoelectric device block provided with an exposed outer sidewall face of respective thermoelectric semiconductors positioned at opposite ends in the direction along which the respective thermoelectric semiconductors are arranged, and an electroless plating film may be also formed on the exposed outer sidewall faces as well in the step of forming the electroless plating film.

Further, in the case of applying the electroless plating method according to the invention to the fabrication of a thermoelectric device, the electroless plating method preferably comprises the step of rendering the end face of the thermoelectric device block into a rough surface prior to the step of forming the electroless plating film on the thermoelectric device block.

Still further, the electroless plating method preferably comprises the step of cleaning the thermoelectric device block before or after the step of forming the electroless plating film on the thermoelectric device

block.

And further, the present invention provides an electroless plating method comprising the steps of preparing an object to be plated, comprised of metal or semiconductors, to which an electroless plating can not be applied, and insulators, and forming a metallic film made of a metal on which an electroless plating film can be deposited on part of the surface of the object to be plated, or causing the metal to be in contact with part of the surface of the object to be plated, and dipping the object to be plated having the metallic film formed thereon or having the metal in contact therewith in an electroless plating bath, and forming an electroless plating film on the entire surface of the object to be plated, except for the insulators.

As the constituent material to which an electroless plating can not be applied, use can be made of a metal or a semiconductor, to which an electroless plating can not be applied.

As the metal on which the electroless plating film can be deposited, use can be made of palladium, platinum or nickel.

An insulating resin is preferably used for the insulators or the insulation layers.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a sectional view showing a state wherein a metallic film made of a metal on which an electroless plating film can be deposited is formed on part of the surface of a thermoelectric semiconductor by the invention;

Fig. 2 is a sectional view showing a state wherein a conductive film according to an electroless plating film is formed on the entire

surface of the thermoelectric semiconductor and the metallic film;

Fig. 3 is a sectional view schematically showing a thermoelectricdevice block to which electroless plating is applied by the invention;

Figs. 4 to 8 are sectional views sequentially showing respective steps of applying electroless plating to the thermoelectric device block according to a first embodiment of the invention;

Figs. 9 to 11 are sectional views sequentially showing respective steps of applying electroless plating to the thermoelectric device block according to a second embodiment of the invention;

Figs. 12 and 13 are sectional views sequentially showing respective steps of applying electroless plating to the thermoelectric device block according to a third embodiment of the invention;

Figs. 14 to 16 are sectional views sequentially showing respective steps of applying electroless plating to the thermoelectric device block according to a fourth embodiment of the invention;

Fig. 17 is a sectional view showing a state wherein probes are caused to be in contact with the thermoelectric device block in applying electroless plating to the thermoelectric device block according to the